

U.S. Application No. 09/734,228  
Reply to Office Action of April 21, 2006

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### IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application. An identifier indicating the status of each claim is provided.

#### Listing of Claims

1. (Currently Amended) A method for recognizing speech, comprising:

(a) receiving a speech phrase;

(b) generating a signal being representative to said speech phrase;

(c) pre-processing and storing said signal with respect to a determined set of rules;

(d) generating from said pre-processed signal at least one series of hypothesis speech elements;

(e) determining at least one series of words being most probable to correspond to said speech phrase by applying a predefined language model to said at least one series of hypothesis speech elements,

wherein determining said at least one series of words further comprises:

(1) determining at least one sub-word, word, or a combination of words most probably being contained as a seed sub-phrase in said received speech phrase,

wherein said seed sub-phrase is recognized with an appropriate high degree of reliability, such that segments of speech that are recognized with high reliability are used to constrain the search in other areas of the speech signal where the language model employed cannot adequately restrict the search; and

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(2) continuing determining words or combinations of words, which are consistent with said seed sub-phrase as at least a first successive sub-phrase which is contained in said received speech phrase, by inserting additional, paired and/or higher order information, including semantic and/or pragmatic information, between the sub-phrases, thereby decreasing the burden of searching,

wherein said semantic information includes description of said sub-phrases and said pragmatic information includes connecting information connecting said sub-phrases to actual situation, application, and/or action,

wherein the predefined language model contains a low-perplexity recognition grammar obtained from a conventional recognition grammar by:

(3) identifying and extracting word classes of high-perplexity from the conventional grammar;

(4) generating a phonetic, phonemic and/or syllabic description of the high-perplexity word classes, in particular by applying a sub-word-unit grammar compiler to them, to produce a sub-word-unit grammar for each high-perplexity word class; and

(5) merging the sub-word-unit grammars with the remaining low-perplexity part of the conventional grammar to yield said low-perplexity recognition grammar; and

~~wherein said at least one series of words substantially comprises at least one low-perplexity part which can be analyzed and recognized with a high degree of reliability, and remaining parts which are treated as high-perplexity parts, and~~

~~wherein pragmatic information contained in said at least one low-perplexity part with respect to at least one of said high-perplexity parts may be used to explain said at least one of said high-perplexity parts;~~

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wherein a language model is used containing at least a recognition grammar built up by at least a low-perplexity part and a high-perplexity part, each of which being representative for distinct low- and high-perplexity classes of speech elements; and wherein word classes are used as classes for speech elements or fragments.

2. (Original) Method according to claim 1, characterized in that a predefined language model is applied to at least said series of hypothesis speech elements to obtain said seed sub-phrase and said additional and paired and/or higher order information is obtained from said language model.

3. (Canceled)

4. (Previously Presented) Method according to claim 1, characterized in that additional information within said language model is used being descriptive for the prepositional relationship of the sub-phrases.

5. (Previously Presented) Method according to claim 1, characterized in that additional information within that language model is used being descriptive for pairs, triples and/or higher order n-tuples of sub-phrases.

6-8. (Canceled)

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9. (Previously Presented) Method according to claim 1, characterized in that a hypothetical graph is generated for the received speech phrase including the generated sub-phrases and/or their combinations as candidates for the recognized speech phrase and that additional information between the sub-phrases is used to constrain and to restrict the search for the most probable candidate within the graph.

10. (Original) Method according to claim 9, characterized in that during the search candidate sub-phrases or sub-words from the high-perplexity word classes are inserted into the hypothesis graph, whereby the sub-word unit grammars for the high-perplexity word classes are used as constraints as well as the respective additional semantic and/or pragmatic information.

11. (Original) Method according to claim 10, characterized in that according to the constraints candidates are deleted from the hypothesis graph until an unbranched resulting graph is generated, corresponding to the most probable phrase.

12. (Previously Presented) Method according to claim 1, characterized in that the vocabulary - in particular of said language model - applicable for the remaining parts of the speech phrase besides the seed sub-phrase is restricted at least for one remaining part so as to decrease the burden of search.

13. (Canceled)

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14. (Currently Amended) An apparatus for recognizing speech, comprising:

(a) means for receiving a speech phrase;

(b) means for generating a signal being representative to said speech phrase;

(c) means for pre-processing and storing said signal with respect to a

determined set of rules;

(d) means for generating from said pre-processed signal at least one series of hypothesis speech elements;

(e) means for determining at least one series of words being most probable to correspond to said speech phrase by applying a predefined language model to said at least one series of hypothesis speech elements,

wherein said means for determining said at least one series of words further comprises:

(1) means for determining at least one sub-word, word, or a combination of words most probably being contained as a seed sub-phrase in said received speech phrase,

wherein said seed sub-phrase is recognized with an appropriate high degree of reliability, such that segments of speech which can be recognized with high reliability are used to constrain the search in other areas of the speech signal where the language model employed cannot adequately restrict the search; and

(2) means for continuing determining words or combinations of words, which are consistent with said seed sub-phrase as at least a first successive sub-phrase which is contained in said received speech phrase, by inserting additional, paired and/or higher order information, including semantic and/or pragmatic information, between the sub-phrases, thereby decreasing the burden of searching,

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wherein said semantic information includes description of said sub-phrases and said pragmatic information includes connecting information connecting said sub-phrases to actual situation, application, and/or action, and

wherein the predefined language model includes a low-perplexity recognition grammar obtained from a conventional recognition grammar by using:

(3) means for identifying and extracting word classes of high-perplexity from the conventional grammar;

(4) means for generating a phonetic, phonemic and/or syllabic description of the high-perplexity word classes, in particular by applying a sub-word-unit grammar compiler to them, to produce a sub-word-unit grammar for each high-perplexity word class;

(5) means for merging the sub-word-unit grammars with the remaining low-perplexity part of the conventional grammar to yield said low-perplexity recognition grammar; and

~~wherein said at least one series of words substantially comprises at least one low-perplexity part which can be analyzed and recognized with a high degree of reliability, and remaining parts which are treated as high-perplexity parts, and~~

~~wherein pragmatic information contained in said at least one low-perplexity part with respect to at least one of said high-perplexity parts may be used to explain said at least one of said high-perplexity parts;~~

wherein a language model is used containing at least a recognition grammar built up by at least a low-perplexity part and a high-perplexity part, each of which being representative for distinct low- and high-perplexity classes of speech elements; and

wherein word classes are used as classes for speech elements or fragments.

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15. (Previously Presented) The apparatus of claim 14, wherein said semantic information includes information relating to grammatical constraints among said sub-phrases.

16. (Previously Presented) The apparatus of claim 15, wherein said information relating to grammatical constraints include grammatical constraints for a name of a city.

17. (Previously Presented) The apparatus of claim 16, wherein said pragmatic information includes a 5-digit postal code for the city.

18. (Previously Presented) The method of claim 1, wherein said seed sub-phrase recognized with an appropriate high degree of reliability is defined as a low perplexity part of said received speech phrase.

19. (Previously Presented) The method of claim 18, wherein perplexity is defined as the complexity of the depth of search which has to be accomplished in conventional search graphs or search trees.

20. (Previously Presented) The apparatus of claim 14, wherein said seed sub-phrase recognized with an appropriate high degree of reliability is defined as a low perplexity part of said received speech phrase.

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21. (Previously Presented) The apparatus of claim 20, wherein perplexity is defined as the complexity of the depth of search which has to be accomplished in conventional search graphs or search trees.